[Translation from French]

FRENCH REPUBLIC

MINISTRY OF COMMERCE AND INDUSTRY

OFFICE OF INDUSTRIAL PROPERTY

PATENT OF INVENTION

Group 12 - Class 2 **No. 741,148**

Novel anticathode for X-ray tubes operating at very high voltages

Mr. Heliodoro Teodoro TELLEZ-PLASENCIA, residing in Spain

Filed on 5 November 1931 at 3 p.m. in Bordeaux

Granted on 2 December 1932 – Published on 6 February 1933

[Patent of invention, grant of which was postponed in pursuance of Art. 11, §7 of Act of 5 July 1844 as amended by Act of 7 April 1902]

One of the greatest difficulties found in the technology of X-ray tubes operating at very high voltages or at very high power derives from the difficulty of eliminating the heat produced in the anticathode. Cooling is usually accomplished either by radiation or by circulation of water in the center of the anticathode.

In the first case, thermal equilibrium is established only at very elevated temperatures; this has a deleterious effect on the glass of the bulbs, which must have a great diameter, and at the same time complicates the vacuum technique, because of strong release of the gases occluded in all of the mass of the anticathode, and of inevitable evaporation of the metal of the latter.

In the second case, the heat must be transmitted by conductivity through a given thickness of the metal, from the point of impact where it is produced, to the cooling

liquid, which requires a temperature gradient more elevated as the power to dissipate is greater.

These difficulties disappear if, as has been done in the tube which is the subject of the invention, the solid anticathode is totally replaced by a fluid mass that is constantly renewed, so that each of its parts is successively exposed to cathodic corpuscular bombardment, and carried to the outside in order to eliminate the stored heat. In the accompanying drawings, and by way of example, in no way limitative, Figures 1 and 2 show two different methods of use of the fluid anticathode.

The liquid constituting the self-cooling anodic metal is mercury, which may be replaced by any other desired substance, simple or compound, whose characteristics of chemical stability, atomic weight, melting and boiling temperatures, make use and favorable output possible under the conditions stated. In particular, it may be replaced by amalgams or by any of the alloys based on lead or bismuth, which are very easily fusible.

The anodic liquid circulates in the interior of the anticathode 1, the wall 2 of which, exposed to the cathodic rays, has, per unit of surface, a mass small enough to retain only a small fraction of the electrons. The rest of these will thus be absorbed by the liquid itself, leave its electric charge there, and there transform its energy into heat and into radiation, the characteristics of which will depend, according to known physical laws, upon their velocity and the nature of the substance constituting the anodic fluid.

The heat produced will be distributed in a depth of the fluid which is greater as the velocity of the electrons is higher and their force of penetration greater. The increase in electric voltage applied to the tube will favor, rather than impede, as is the

case in the present tubes, the increase in the working power of the bulb, since, by elevating the voltage, the volume of fluid in which the heat will be stored is multiplied.

After its passage to the anticathode, the anodic fluid may be conducted, by means of a suitable channel 3 to disperse its heat in a coolant of any kind whatsoever: radiating into the air or into another gas, a coil, into a liquid or other.

The surface of the anticathode receiving the electron jet may be disposed, relative to this same jet: either obliquely (Fig. 2), so as to employ the radiation emitted toward its outside by the said surface, as in the X-ray tubes currently used; or normally (Fig. 1), by then using the part of the X-radiation emitted in the same direction and in the same sense as the cathodic beam, and, therefore, through the anodic fluid, which then serves as a filter for the X-rays, and the thickness of which consequently must be determined. In this last form of use of the invention, the anticathode may be disposed at one of the ends of the tube, and grounded, which in medical applications permits either disposing the source of the rays in the immediate vicinity of the lesions, or utilizing the radiation emitted at a solid angle of almost one hemisphere, for the treatment of several patients at once.

The cathode 4 may then be disposed, either opposite and at a short distance from the anticathode, at the anodic end of the X-ray tube (the latter would then be, entirely, a simple cathodic collar), or toward the center of the tube; the high-voltage field accelerating the electrons would be established, in this latter case, between the cathode 4 and a hollow cylinder 5, the axis of which would coincide with that of the cathodic beam. One of the ends of this cylinder, the one (6) which is near the cathode, would have a shape suitable for playing the role of an anode of the high-voltage electric field;

the electrons would pass into the cylinder, through which they would travel in the direction of the length, and would strike against the surface of the anticathode, which would close the other end of the cylinder transversely. Lastly, the voltage would be applied either in a single stage, or be distributed among a number of similar elements disposed in cascade.

The whole of the tube may be sealed, in order to permit it to maintain a permanent vacuum, or manufactured in pieces capable of being taken apart and connected through 7 fixed to a vacuum pump, which would have to function during operation of the tube to ensure maintenance of a perfect vacuum.

CLAIMS

X-ray tube capable of functioning at all voltages and under all systems, characterized in that:

1. The anticathode is formed by a renewable fluid mass, circulating during operation of the tube, and for this reason itself playing the role of coolant; contained in an enclosure whose mass per unit of surface is, in the part exposed to the cathodic beam, small enough for the greatest part of the electrons to be able to pass into the fluid mass itself.

2. The part of the X-radiation emitted in the prolongation of the cathodic beam may be employed through the fluid mass which then, all by itself, plays the triple role of anticathode, coolant and filter.

3. The X-radiation emitted may likewise be utilized in a direction going toward the exterior of the surface subjected to the cathodic beam, thus not passing through the fluid mass, as happens in X-ray tubes with a solid anticathode.

Heliodoro Teodoro TELLEZ-PLASENCIA